10/501134

PCT/ SE 03/00034
13 JUL 2004

PRV

PATENT- OCH REGISTRERINGSVERKET
Patentavdelningen

REC'D 28 JAN 2003
WIPO PCT

Intyg
Certificate

Härmed intygas att bifogade kopior överensstämmer med de handlingar som ursprungligen ingivits till Patent- och registreringsverket i nedannämnda ansökan.

This is to certify that the annexed is a true copy of the documents as originally filed with the Patent- and Registration Office in connection with the following patent application.

PATENT- OCH REGISTRERINGSVERKET

(71) *Sökande* *Telefonaktiebolaget L M Ericsson (publ), Stockholm*
Applicant (s) *SE*

(21) *Patentansökningsnummer* *0200106-3*
Patent application number

(86) *Ingivningsdatum* *2002-01-14*
Date of filing

Stockholm, 2003-01-20

För Patent- och registreringsverket
For the Patent- and Registration Office

Gözel Gustafsson

Avgift
Fee

PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

BEST AVAILABLE COPY

PATENT- OCH REGISTRERINGSVERKET
SWEDEN
Postadress/Adress Box 5055 S-102 42 STOCKHOLM
Telefon/Phone +46 8 782 25 00 Vx 08-782 25 00
Telex 17978 PATOREG S
Telefax +46 8 666 02 86 08-666 02 86

1 A METHOD AND ARRANGEMENT FOR PAGING IN A MOBILE TELECOMMUNICATION SYSTEM

1.1 Technical field of the invention

The invention relates to paging and in particular for Discontinuous Reception (DRX) for GERAN Iu mode

1.2 Background

To save a mobile station's battery while it is in idle mode the time it has to receive and decode information shall be minimised. Therefor the paging channels are divided into several paging groups. The group in which a particular mobile station resides is known locally by both the MS and the network. Paging requests to a specific mobile station is then scheduled and sent at a time derived from MS unique information (IMSI) and information known by both the MS and the network. Thus, the MS knows when relevant page requests will be sent and can power down for the period when it knows that page requests will not occur.

This invention deals with DRX for mobile stations in GERAN Iu mode.

When introducing GERAN Iu mode a way of combining procedures over the Um interface used in GPRS with the procedures used over the Iu interface is needed.

1.3 Abbreviations

2G-MSC	An MSC in the 2G core network connected to GERAN via the A interface.
2G-SGSN	A SGSN in the 2G core network connected to GERAN via the Gb interface.
3G-MSC	An MSC in the 3G core network connected to GERAN or UTRAN via the Iu-cs interface.
3G-SGSN	A SGSN in the 3G core network connected to GERAN or UTRAN via the Iu-ps interface.
A/Gb mode	Mode of operation of the MS when connected to the Core Network via GERAN and the A and/or Gb interfaces.
BSS	Base Station Subsystem
CN	Core Network
CS	Circuit Switched
DRX	Discontinuous Reception
GERAN	GSM EDGE Radio Access network
IE	Information Element
IMSI	International Mobile Subscriber Identity

Iu mode	Mode of operation of the MS when connected to the Core Network via GERAN or UTRAN and the Iu interface.
MSC	Mobile Services Switching Centre
NAS	Non-Access Stratum
NMO	Network Mode of Operation
O&M	Operation & Maintenance
PS	Packet Switched
RAN	Radio Access Network
RANAP	Radio Access Network Application Part
RRC	Radio Resource Control
SGSN	Serving GPRS Support Node
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
UTRAN	UMTS Terrestrial Radio Access Network

1.4 State-of-the-art

In GERAN Iu mode cells support of PBCCH/PCCCH is mandatory (working assumption in the standardisation work).

At the moment no solution for DRX in Iu mode has been agreed upon. During standardisation work some suggestions have come up.Below one suchsolution is briefly outlined.

- GERAN broadcasts a DEFAULT_SPLIT_PG_CYCLE on PBCCH. The MS uses the DEFAULT_SPLIT_PG_CYCLE in RRC-Idle mode.
- The MS provides the GERAN with the GERAN_SPLIT_PG_CYCLE during RRC Connection Setup. This MS specific GERAN_SPLIT_PG_CYCLE is used in RRC-Connected mode.
- In a RANAP Raging Request message a 3G-SGSN includes the PS CN domain DRX Cycle Length Coefficient. The GERAN ignores this parameter. Instead the DEFAULT_SPLIT_PG_CYCLE (RRC-Idle mode) or the GERAN_SPLIT_PG_CYCLE (RRC-Connected mode) is used.
- An MS may, when it attaches to a 3G-SGSN via a GERAN, in the GPRS Attach message include the "legacy GPRS" SPLIT_PG_CYCLE. The "legacy GPRS" SPLIT_PG_CYCLE will not be used as long as the MS stays within cells supporting GERAN Iu mode but can be used if the MS moves to a cell with only A/Gb mode (GPRS) support. If the "legacy GPRS" SPLIT_PG_CYCLE is available to the 3G-SGSN it will be sent to the 2G-SGSN upon cell change.
- If an MS moves from a cell supporting only A/Gb mode (GPRS) to a UTRAN cell it shall include the DRX Cycle Length Coefficient in the Routing Area Update message (This is not a GERAN Iu mode specific requirement and is already today specified).

- If an MS moves from a cell supporting only A/Gb mode (GPRS) to a cell supporting GERAN Iu mode it shall include the DRX Cycle Length Coefficient in the Routing Area Update message for use if the mobile station later moves to an UTRAN cell. This is because a later movement to a UTRAN cell from a GERAN Iu cell will not necessarily result in a change of Routing Area.

This solution has the following implications:

- RANAP will not be impacted.
- The MS loses the possibility (it has in GPRS) to decide what DRX value to use in RRC-Idle mode.
- The MS must support all values of the default DEFAULT_SPLIT_PG_CYCLE that are allowed to be broadcast by the GERAN.
- In GPRS the range of available SPLIT_PG_CYCLEs is large (see below, Appendix A). In UTRAN there are only four DRX cycle length coefficients. For GERAN Iu mode the number of allowed values of DEFAULT_SPLIT_PG_CYCLE can probably be reduced to the order of four.

1.5 Summary of the invention

When introducing GERAN Iu mode a way of combining procedures over the Um interface used in GPRS with the procedures used over the Iu interface is needed. The solution that has been suggested in standardisation solves this but a shortcoming of this solution is that the MS loses the possibility to decide what DRX value to use in RRC-Idle mode when connected to the CS CN domain. This is a step backwards compared to the present methods in both GPRS and in UTRAN respectively and can cause problems in the mobile station implementation.

The solution this invention is based on choosing values of the existing SPLIT_PG_CYCLE of GPRS that fulfil the requirements that they produce paging cycles that overlap each other. These SPLIT_PG_CYCLES cycles are preferably mapped to the DRX cycle length coefficient used in UTRAN possible in a way that keeps the approximate time between the paging occasions the in UTRAN and GERAN. The solution affects both CS and PS CN paging and GERAN paging.

1.6 Preferred Embodiments

A number of new parameters are introduced. Preferably the following three are used:

- CS_SPLIT_PG_CYCLE: This parameter is broadcast on the PBCCH.

- PS_SPLIT_PG_CYCLE: The MS will use a table to map PS_SPLIT_PG_CYCLE to a corresponding value of the CN Specific DRX cycle length coefficient and use this value in the GPRS Attach Request message and the Routing Area Update message sent to the 3G-SGSN. The 3G-SGSN will not know that this is coming from GERAN. In the Paging Request message (RANAP) sent from the 3G-SGSN the CN Specific DRX cycle length coefficient is included and the GERAN will map it to the corresponding value of PS_SPLIT_PG_CYCLE.

  A default value of PS_SPLIT_PG_CYCLE should either be broadcast on PBCCH, set in standard, or stored on the SIM card. If no PS_SPLIT_PG_CYCLE is negotiated in the NAS procedure the default value shall be used

- GERAN_SPLIT_PG_CYCLE: The MS provides the GERAN with the GERAN_SPLIT_PG_CYCLE during the RRC connection setup. This MS specific SPLIT_PG_CYCLE is used in RRC connected mode.

In RRC-Idle mode the following applies:

- If the mobile station is connected only to the CS domain it shall use CS_SPLIT_PG_CYCLE.
- If the mobile station is connected only to the PS domain it shall use PS_SPLIT_PG_CYCLE.
- If the mobile station is connected to both the CS and PS domain it shall use shorter of the PS and CS split cycles (the highest value of CS_SPLIT_PG_CYCLE and PS_SPLIT_PG_CYCLE).

In RRC-Connected mode the shortest of the following split cycles is used:

- The split cycle defined by GERAN_SPLIT_PG_CYCLE and,
- the split cycle for RRC-Idle mode as defined above.

The following rules also applies:

- An MS may, when it attaches to a 3G-SGSN via a GERAN, in the GPRS Attach message include both the "legacy GPRS" SPLIT_PG_CYCLE and the DRX Cycle Length Coefficient derived from the PS_SPLIT_PG_CYCLE. The "legacy GPRS" SPLIT_PG_CYCLE will not be used as long as the MS stays within cells supporting GERAN Iu mode but can be used if the MS moves to a cell with only A/Gb mode (GPRS) support. If the "legacy GPRS" SPLIT_PG_CYCLE is available to the 3G-SGSN it will be sent to the 2G-SGSN upon cell change.
- If an MS moves from a cell supporting only A/Gb mode (GPRS) to a UTRAN cell it shall include the DRX Cycle Length Coefficient in the Routing Area Update message (This is not a GERAN Iu mode specific requirement and is already today specified).

- If an MS moves from a cell supporting only A/Gb mode (GPRS) to a cell supporting GERAN Iu mode it shall include the DRX Cycle Length Coefficient derived from the PS_SPLIT_PG_CYCLE in the Routing Area Update message for use if the mobile station later moves to an UTRAN cell.
- If an MS moves from a UTRAN cell to a GERAN Iu cell no new transfer of DRX parameters over the radio interface is needed. The 3G-SGSN will use the DRX Cycle Length Coefficient and the GERAN will map this to the PS_SPLIT_PG_CYCLE.

Mapping of DRX cycle length coefficient and SPLIT_PG_CYCLE

The DRX Cycle Length is calculated from the DRX Cycle Length Coefficient according to:

DRX Cycle Length = 2^k frames,

where k is the DRX Cycle Length Coefficient and one frame corresponds to 10 ms.

To calculate the period between pages to a mobile station from the SPLIT_PG_CYCLE the following approximate equation is used.

Period between pages = 64 52-multi frames / SPLIT_PG_CYCLE

= 15.36 s / SPLIT_PG_CYCLE

It is preferable if the DRX behaviour in a GERAN Iu cell and a UTRAN cell is comparable. Therefor the mapping between DRX Cycle Length Coefficient and SPLIT_PG_CYCLE should be such that the period between pages to a mobile station is similar or the same for corresponding values. In Table 1 below a mapping fulfilling this is suggested. The mapping also satisfies the periodicity requirement that a shorter period is an integer number of shorter periods.

Other values of the SPLIT_PG_CYCLE that fulfils the requirement of periodicity may also be used and mapped to the DRX cycle length coefficient.

Table 1: Suggested mapping between DRX cycle length coefficient and SPLIT_PG_CYCLE. DRX cycle length coefficients 3-5 can only be used in UTRAN Connected mode and RRC-Connected mode.

DRX cycle length coefficient	DRX cycle length	Period (s)	SPLIT_PG_CYCLE	Period (s)
3	8	0.08	192	0.08
4	16	0.16	96	0.16
5	32	0.32	48	0.32

6	64	0.64	24	0.64
7	128	1.28	12	1.28
8	256	2.56	6	2.56
9	512	5.12	3	5.12

Value range of parameters

An example of how the value range for the new parameters is:

CS_SPLIT_PG_CYCLE

- Broadcast on PBCCH.
- Suggested range: 3, 6, 12, and 24.

PS_SPLIT_PG_CYCLE

- Mapped to CN Specific DRX Cycle Length Coefficient in the DRX Parameter IE according to Table 1. No change to the IE is needed.
- Default value broadcast on PBCCH, specified in standard, or stored on the SIM card.
- Suggested range: 3, 6, 12, and 24.

GERAN_SPLIT_PG_CYCLE

- In UTRAN the range for the UTRAN DRX Cycle Length Coefficient is 3 to 9 (integer). It seems reasonable to use a corresponding range for GERAN_SPLIT_PG_CYCLE.
- Suggested range: 3, 6, 12, 24, 48, 96, and 192.

GERAN_SPLIT_PG_CYCLE could be included in the following messages:

- Cell Update Confirm
- GRA Update Confirm
- Radio Bearer Reconfiguration
- Radio Bearer Release
- Radio Bearer Setup
- RRC Connection Setup

Comments

- RANAP will not be impacted.
- The number of allowed SPLIT_PG_CYCLEs for a GERAN Iu MS will be four. This is the same as for UTRAN but a significant reduction compared to GPRS.

1.7 Merits of the invention

The core advantage of this solution is that a mobile station in RRC-Idle mode has control over the DRX period. If the MS is connected to only the PS domain it has the option of using a long "sleep time". This is reasonable since this is the case both in GPRS and UTRAN and since the mobile station best can decide how quickly is shall receive a page.

1.8 Related documents

Standards documents

3GPP TS 03.13 "Discontinuous Reception (DRX) in the GSM system"
3GPP TS 05.02 "Multiplexing and multiple access on the radio path"
3GPP TS 24.008 "Mobile radio interface layer 3 specification; Core Network Protocols - Stage 3"
3GPP TS 25.304 "UE Procedures in Idle Mode and Procedures for Cell Reselection in Connected Mode"
3GPP TS 25.331 "RRC Protocol Specification"
3GPP TS 25.413 "UTRAN Iu Interface RANAP Signalling"
3GPP TS 44.018 "Mobile radio interface layer 3 specification; Radio Resource Control Protocol"
3GPP TS 44.060 "General Packet Radio Service (GPRS); Mobile Station (MS) - Base Station System (BSS) interface; Radio Link Control/Medium Access Control (RLC/MAC) protocol"

Other documents

"Discontinuous Reception (DRX) and Network Modes of Operation (NMO) for GERAN Iu", Nokia, GP-012610, Cancún, Mexico.
"Report of TSG GERAN meeting #7", 26th-30th November 2001, Cancún, Mexico.

These documents can be downloaded from:
ftp://ftp.3gpp.org/tsg_geran/TSG_GERAN/GERAN_07_Cancun

A revised version of the Nokia dokument has been presented under number G2-020062.

Ericsson Review No. 3, 2001, Frank Müller et al: Further evolution of the GSM/EDGE radio access network.

The related documents are incorporated in this application by reference and background art.

The invention has mainly been described in the relation to the GERAN Iu mode. However, a skilled person realises that the idea and concept of the invention could be implemented in other systems whenever there is a need for combination of paging with discontinous reception in combinations of different paging principles.

A DRX parameter information element

8	7	6	5	4	3	2	1	
DRX parameter IEI								octet 1
SPLIT PG CYCLE CODE								octet 2
CN Specific DRX cycle length coefficient				SPLIT on CCCH	non-DRX timer			octet 3

SPLIT PG CYCLE CODE, octet 2
The octet contains the binary coded value of the SPLIT PG CYCLE CODE. The SPLIT PG CYCLE value is derived from the SPLIT PG CYCLE CODE as follows:

0	704 (equivalent to no DRX)
1 to 64	1 to 64, respectively
65	71
66	72
67	74
68	75
69	77
70	79
71	80
72	83
73	86
74	88
75	90
76	92
77	96
78	101
79	103
80	107
81	112
82	116
83	118
84	128
85	141
86	144
87	150
88	160
89	171
90	176
91	192
92	214
93	224
94	235
95	256
96	288
97	320
98	352

All other values are reserved and shall be interpreted as 1 by this version of the protocol.

SPLIT on CCCH, octet 3 (bit 4)

0	Split pg cycle on CCCH is not supported by the mobile station
1	Split pg cycle on CCCH is supported by the mobile station

non-DRX timer, octet 3
bit

3	2	1	
0	0	0	no non-DRX mode after transfer state
0	0	1	max. 1 sec non-DRX mode after transfer state
0	1	0	max. 2 sec non-DRX mode after transfer state
0	1	1	max. 4 sec non-DRX mode after transfer state
1	0	0	max. 8 sec non-DRX mode after transfer state
1	0	1	max. 16 sec non-DRX mode after transfer state
1	1	0	max. 32 sec non-DRX mode after transfer state
1	1	1	max. 64 sec non-DRX mode after transfer state

CN Specific DRX cycle length coefficient, octet 3
bit

8	7	6	5	UMTS specific
0	0	0	0	CN Specific DRX cycle length coefficient not specified by the MS, ie. the system information value 'CN domain specific DRX cycle length' is used. (Ref 3GPP TS 25.331)
0	1	1	0	CN Specific DRX cycle length coefficient 6
0	1	1	1	CN Specific DRX cycle length coefficient 7
1	0	0	0	CN Specific DRX cycle length coefficient 8
1	0	0	1	CN Specific DRX cycle length coefficient 9

All other values shall be interpreted as "CN Specific DRX cycle length coefficient not specified by the MS" by this version of the protocol.
Note: In UMTS this field (octet 3 bits 8 to 5) is used, but was spare in earlier versions of this protocol.

DRX parameter information element [section 10.5.5.6 of 24.008].